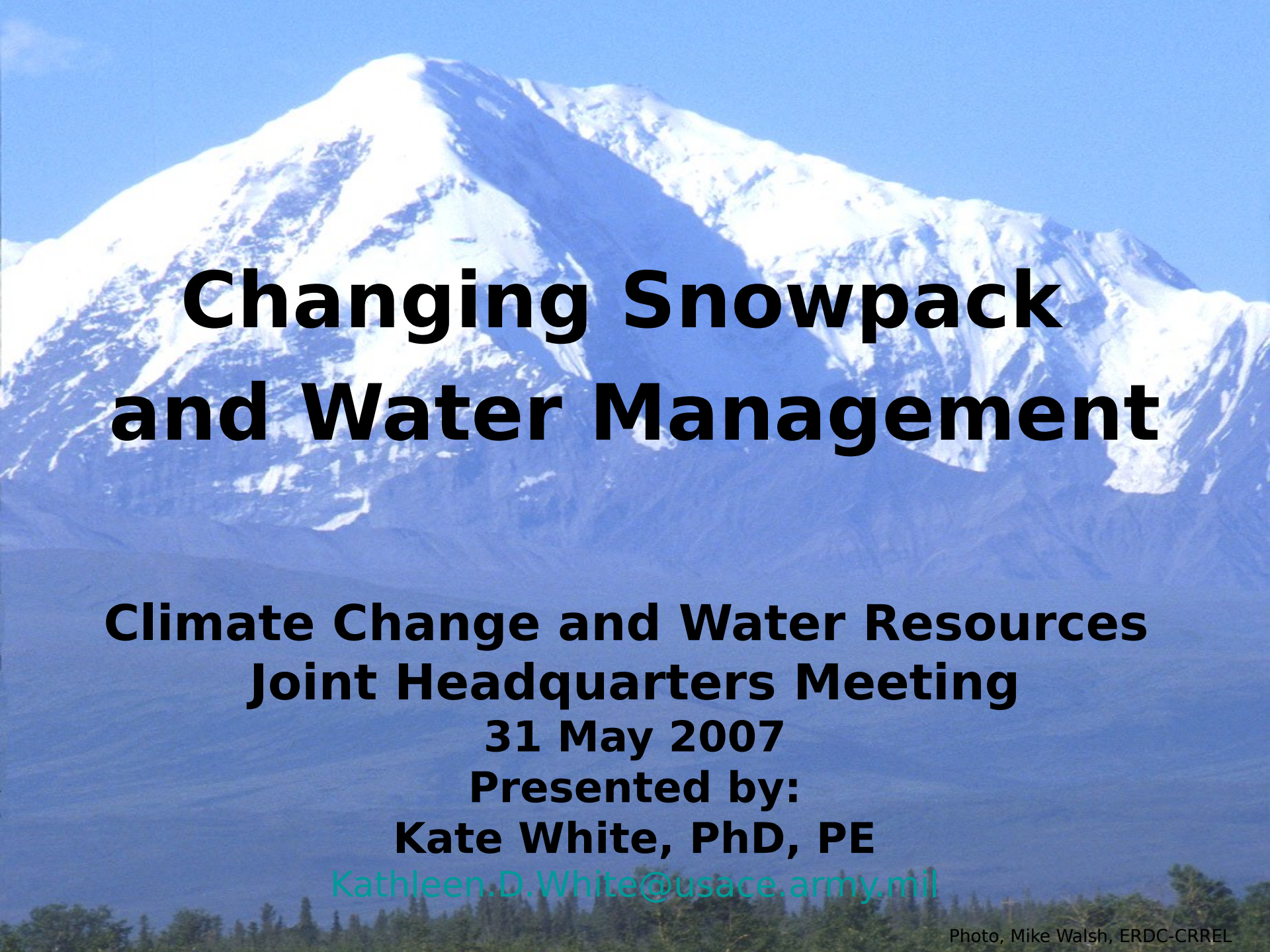

Changing Snowpack and Water Management

Climate Change and Water Resources
Joint Headquarters Meeting
31 May 2007

Presented by:
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Photo, Mike Walsh, ERDC-CRREL

Corps experiences

- **From Corps Climate Workshop, Nov 2004:**
  - **Baltimore, Sacramento, Detroit, Walla Walla, Seattle, Portland, Fort Worth, Jacksonville, and Galveston Districts, South Atlantic Division, Lakes and Rivers Division**
  - **HQ, ERDC, IWR**
  - **NOAA, NWS, NASA, and USGS**
  - **U Maryland and Washington, Scripps Oceanographic Institute**

Corps experiences

- **Warming is accelerating and will continue**
- **Weather is becoming more energetic and more variable, though specific areas are responding**

differently

Engineer Update, February 1997

The Corps, along with state and local agencies, completed the emergency ring levee around Meridian, Calif., only 100 feet ahead of encroaching flood waters.

Cayan (Scripps/USGS):

- **Rain vs. snow is crucial to water issues in the West**
  - **In CA's Sierra Nevada, only 20-30 days deliver most of the year's water**
  - **Timing of spring runoff 1-3 wks earlier in decades after 1977**
  - **Not only early snowmelt but more immediate rainfall runoff occurred**
- **Trends have been a response to warming trends (not change in precipitation)**

Dettinger (USGS):

- **Trend of increased temperatures in Pacific Northwest snowmelt-dominated watersheds results in**
  - **increased runoff in winter**
  - **less runoff in summer**
  - **earlier peak snowmelt**
  - **earlier peak runoff in spring**
  - **earlier soil moisture recharge in spring**

Dettinger, M.D. (2005) "Changes in streamflow timing in the western United Statesin recent decades." USGS Fact Sheet 2005-

Corps experiences

- **Climate variability is shaping the future of water resources management**
- **Temporal and spatial mismatches of supply and demand are a major problem in water supply**
  - **Increased early flood risk**
  - **Changes in timing and volume of refill**
- **Effects on snowpack are a significant driver**

Corps response

- **Grassroots effort by Corps Climate Focus Group**
  - **Survey of western districts to ID climate drivers**
    - **Regional temperature shifts**
    - **Increased variability and uncertainty in forecasts**
    - **Seasonal timing of large storm events**
    - **Altered seasonality and volume of precipitation**
  - **Surveys ID'd impact pathways:**
    - **Water temperature**
    - **Streamflow timing shifts (shape of hydrograph)**
    - **Annual runoff volume altered**
    - **Pattern of snow accumulation and melt**
    - **Watersheds: snow-dominant vs. rain dominant**
    - **Altered risks for streamflow extremes (high and low flow)**

Corps response

- **Desired improvements in water resources planning and management:**
  - **Flexible Rule Curves and Storage Reservoir Diagrams (SRD)**
    - **Changing operations at dams**
    - **Reservoir evacuation and refill schedules**
    - **Elevation control of lakes (i.e. Lake Washington)**
  - **New Water Control Plans**
    - **Changes to reservoir/water allocations and/or prioritization**
    - **Changing storage needs**

Corps response

- **Desired improvements in water resources planning and management:**
  - **Structural design changes**
    - **Levees, flood risk reduction**
    - **Streamflow forecasts**
  - **Higher resolution remote sensing**
    - **Reduced uncertainty required**
  - **Updated decision support tools**
  - **Biological Opinions (BiOp)**
    - **Reasonable and prudent alternatives (RPAs) and reasonable and prudent measures (RPMs)**
    - **Restoration of normative annual hydrographs & thermographs**

Corps response

- **Significant climate-related capabilities are emerging that we can integrate and leverage**
  - **Improvements to modeling, e.g., inclusion of ground state and improved snowmelt capabilities in HEC-HMS/Corps Water Management System (CWMS)**
  - **Improved snow monitoring via interagency cooperation**
  - **Develop new tools to support climate variability analysis for studies (12 Actions)**

I: Maximize use of interagency data and produ

SNOW COURSE DATA

- NOHRSC Gamma Survey
- Snow Course (various)

SWE
Snow Depth

POINT DATA

- NWS 1st Order Stations
- NWS Cooperative Stations
- SNOTEL Stations

SWE
Snow Depth
Precipitation
Temperature

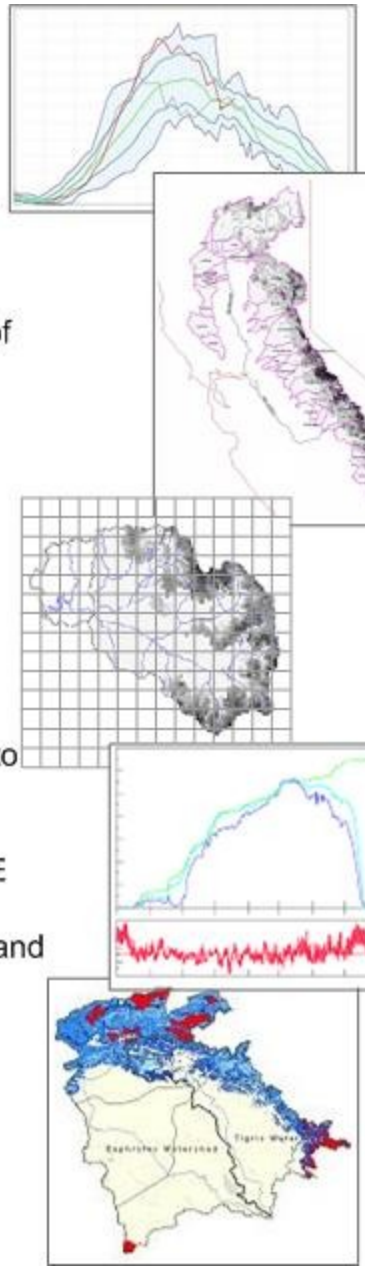
CWMS Database

Snow Properties
SCA
SWE

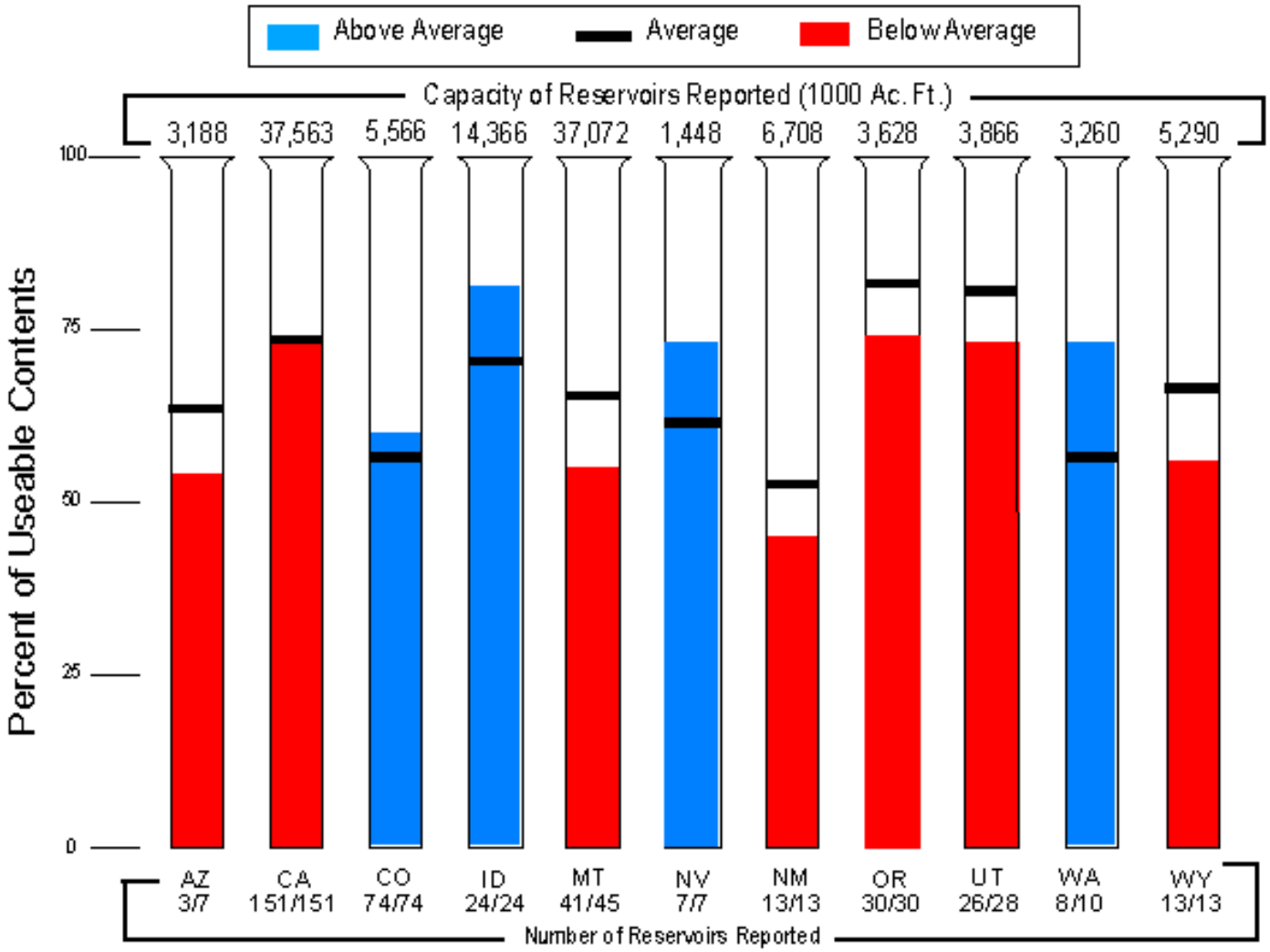
DISTRIBUTED DATA

- NOHRSC NSA (1km)
- Satellite Data
  - SSM/I (25 km)
  - MODIS (500 m)
  - AVHRR (1km)

- Real-Time maps of SWE/ Depth
- HEC-HMS gridded input of snow conditions
- Comparison of real-time watershed SWE with historical
- Comparison of snow distribution maps with historical
- Period of record updates to historical averages
- Real-time watershed SWE
- Tabular displays of SWE and depth by watershed

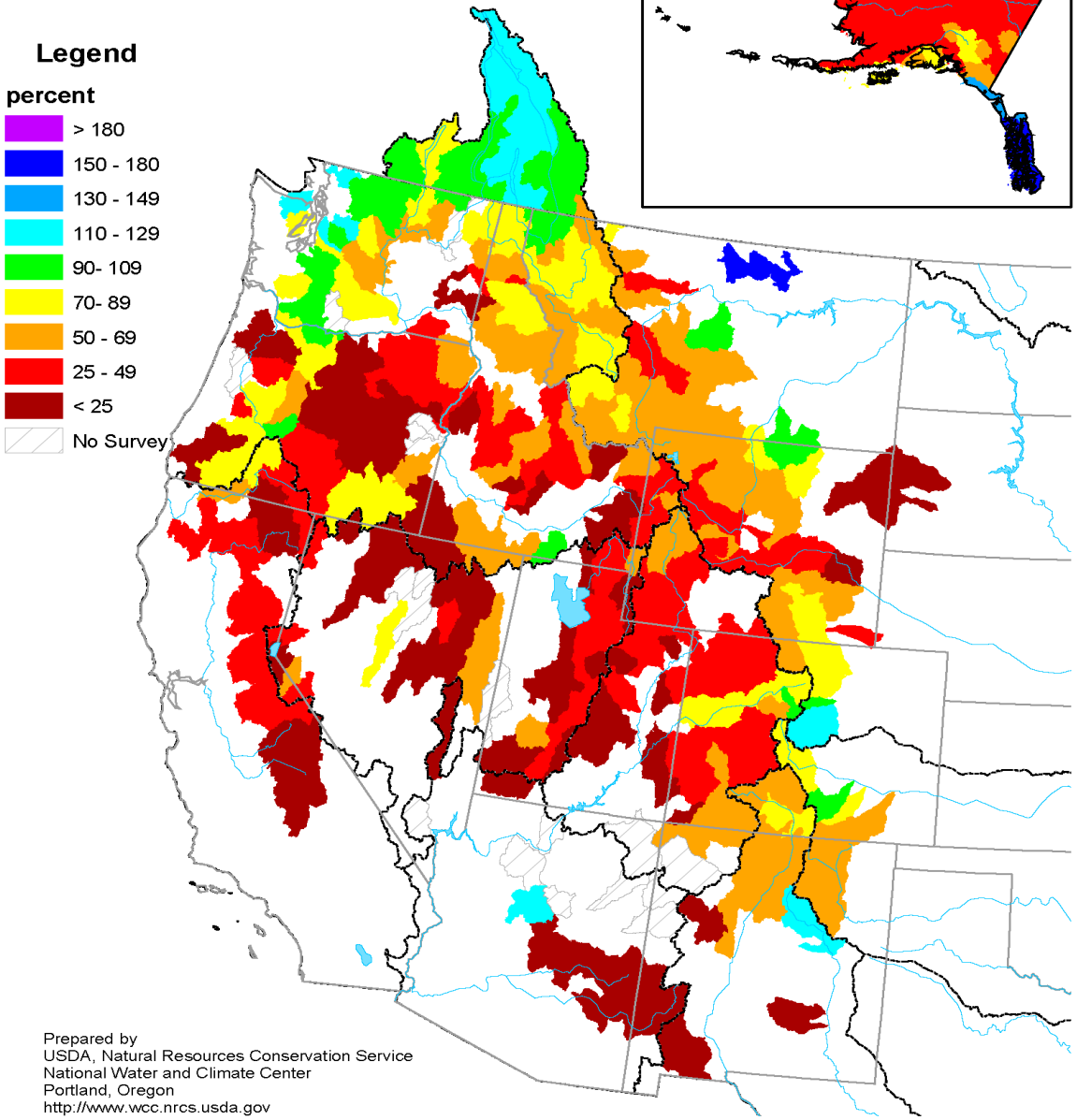


Reservoir Storage as of May 1, 2007



Prepared by: USDA, Natural Resources Conservation Service, National Water and Climate Center, Portland, OR
http://www.wcc.nrcs.usda.gov

Mountain Snowpack as of May 1, 2007



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